Remarks

Claims 1, 3, 6, 7 and 10 are pending herein. By this Amendment, claims 2, 5, 8 and 9 have been canceled, and claims 1, 3 and 10 have been amended. Claim 4 was previously canceled.

Claim 1 has been amended in part to include the contents of canceled claims 2, 5, 8 and 9 and a portion of claim 3. Claims 3 and 10 have been amended to be consistent with the amendments to claim 1.

Claim 1 has also been amended to recite the presence of a plurality of stack-like silicon-layer projections on a surface of the object to be processed and the presence of silicon nitride film on the upper surfaces of the projections. Support for these recitations can be found in the specification at, e.g., Figure 3 and page 10, lines 27-31.

In the Office Action, claims 1-3, 5, 6 and 9 are rejected under 35 U.S.C. §103(a) as being unpatentable over EP Patent No. 1152461 to Shoichi et al. ("Shoichi '461") in view of JP 2002-176052 ("JP '052") in view of WO 00-24049 ("WO '049") and further in view of JP 2001-274154 ("JP '154"); and claims 7, 8 and 10 are rejected under §103(a) as being unpatentable over Shoichi '461 in view of U.S. Patent No. 6,114,258 to Miner et al. ("Miner").

In view of the amendments and remarks herein, Applicants respectfully request reconsideration and withdrawal of the rejections set forth in the Office Action.

I. Rejection of Claims 1-3, 5, 6 and 9

As noted above, claims 1-3, 5, 6 and 9 are rejected under §103(a) as being unpatentable over Shoichi '461 in view of JP '052 in view of WO '049 and further in view of JP '154.

Claims 2, 5 and 9 have been canceled. Claim 1 is independent, and claims 3 and 6 depend upon claim 1. Applicants respectfully submit that claims 1, 3 and 6 would not have been obvious over Shoichi '461 in view of JP '052 in view of WO '049 and further in view of JP '154.

Shoichi '461 and Miner were cited in the Office Action of May 8, 2006. JP '052, WO '049 and JP '154 are newly cited in the current Office Action. Applicants note that JP '052 is the Japanese counterpart to Shoichi '461, and that WO '049 is the PCT counterpart to Miner. The U.S. counterpart to JP '154 is U.S. Patent No. 6,566,199 to Tokai et al. ("Tokai") (copy enclosed).

Regarding instant claim 1, the Office Action states that Shoichi '461 discloses all of the claimed features except for the nitride film and the silicon both being exposed on the surface of

the object to be processed. JP '052, WO '049 and JP '154 are cited for disclosing a method for oxidizing the surface using a hydroxyl group active species and an oxygen active species in a vacuum atmosphere. The Office Action states that, in view of the secondary references, a person skilled in the art "could have easily conceived of employing a work with nitride film and silicon exposed on the surface" in Shoichi '461.

Applicants respectfully submit that JP '052, i.e., the Japanese counterpart to Shoichi '461, does not teach or suggest a nitride film and a silicon both being exposed on the surface of the object to be processed.

Applicants respectfully submit that claims 1, 3 and 6 would not have been obvious over Shoichi '461/JP '052 in view WO '049/Miner and JP '154/ Tokai.

Instant claim 1 has been amended in part to include the following features:

> (i) an oxidizing gas and H_2 gas are fed into said processing container, respectively, by separate gas feed locations, a distance between a region for accommodating the object to be processed in the processing container and each of said gas feed locations being 100 mm or more; and
>
> (ii) a plurality of stack-like silicon-layer projections are formed on a surface of said object to be processed, and a silicon nitride film is formed on upper surfaces of said projections.

In the present invention, the distance between the feed locations of the oxidizing gas and the H_2 gas and the object to be processed contributes to the mixing of the two gases and the supplying of active hydroxyl species and active oxygen species uniformly to the entire surface of the object to be processed. For example, the instant specification teaches the following:

> [a] distance H1 between the wafer-accommodating region as the processing space S and each gas feed location, more specifically the distance H1 between the lower-end portion of the wafer-accommodating region i.e. the lower-end portion of the wafer boat 10 and the gas outlet at the end of each of the nozzles 32 and 40, is spaced apart by a predetermined distance. The purposes of providing the distance H1 in this way is firstly to preheat the gasses by heat radiation from the processing container 8 which is heated by a heater 62 and provides a hot-wall condition while each gas flows upwardly by the distance H1, and secondly ***to fully mix both the gasses while both of the gasses flow upwardly through the distance H1*** [emphasis added]. (page 6, line 28 – page 7, line 3)

> The distance H1 therefore is determined to be 100 mm or above, preferably 300 mm or above, for example which allow the fed oxidizing gas and reducing gas ***to be fully mixed without causing an adverse affect on the temperature distribution in the wafer-accommodating region (processing space S)***. [emphasis added] (page 7, lines 4-8).
>
> By separately feeding H_2 and O_2 into the processing container 8 in this way, O* (active oxygen species), OH* (active hydroxyl species) and H_2O (water vapor) are produced in the course of the combustion reaction of hydrogen, thereby oxidizing the surfaces of the wafers W. ***In this case, it is considered that the above active species O* and OH* highly contribute to the improvement of the film quality and the planar and interplanar uniformity of the film thickness.*** In other words, by performing the oxidation processing in a vacuum atmosphere with a processing pressure quite lower than that in a conventional oxidation method as mentioned above, the chemical reactions, as indicated above by a series of the reaction formulas, proceed slowly as the H_2 gas and O_2 gas flow upwardly inside the processing container 8, thus realizing the condition that the adequate amount of H_2O is available for the wafers W at every height which are therefore subjected ***substantially uniformly to the oxidation reaction. As a result the interplanar uniformity of the film thickness can particularly be improved.*** In more specific terms, the processing pressure is determined to be 133 Pa or below which is quite lower than that in a conventional method as mentioned above, hence resulting in prolonging the lives of both the active species of oxygen and a hydroxyl group. Consequently, these active species flow upwardly through the height H2 of the processing space S without becoming very much extinct and contribute to the oxidation reaction, and thus the interplanar uniformity of the film thickness is improved. [emphasis added] (page 9, lines 18-35)
>
> Moreover, since H_2 gas and O_2 gas are supplied through the distance H1 from the lower-end portion of the processing space S in this case instead of being directly supplied to the processing space S, ***both the gases can be fully mixed while flowing up the length of the distance H1***. [emphasis added] (page 10, lines 7-11).

As pointed out in the November 7, 2006 Amendment, the hydrogen and oxygen gases in Shoichi '461 are supplied into the position located distance H1 from the lower end of the processing space S, whereas in Miner the hydrogen and oxygen gases in Miner are supplied

directly into the processing space. Tokai (JP '154) also teaches that the oxygen and hydrogen gases therein are injected directly into the process chamber. Applicants submit that this difference in gas feeding locations between Shoichi '461 on the one hand and Miner (WO '049) and Tokai (JP '154) on the other hand is evidence of how different the respective oxidation methods are.

Applicants submit that the Shoichi '461 oxidation method and the Miner (WO '049) and Tokai (JP '154) oxidation methods are so different that one skilled in the art would not be motivated to modify the Shoichi '461 method to incorporate features of the Miner (WO '049) and Tokai (JP '154) oxidation methods. For example, in both Tokai (JP '154) and Miner (WO '049):

> - water is the desired product of the reaction between the hydrogen gas and the oxygen gas although "a variety of chemically active reaction species" are also present,
>
> - the oxygen and hydrogen gases are injected directly into the process chamber, and
>
> - the mixture of hydrogen gas and oxygen gas react immediately near the heated substrate.

On the other hand, in Shoichi '461:

> - active hydroxyl and active oxygen species are formed and are the desired products of the reaction between the oxygen and hydrogen gases.
>
> - the oxygen gas and the hydrogen gas are supplied into the position located distance H1 from the lower end of the processing space S rather than supplied directly into the processing space S, and
>
> - the reactions forming the active species occur gradually as the gases flow up the processing vessel.

Thus, Applicants submit that the oxidation methods in Shoichi '461 and Tokai (JP '154) and Miner (WO '049) are so different that one skilled in the art, who wishes to process an object wherein a nitride film and silicon are both exposed on the surface of the object, would not be

motivated to modify any part of the Shoichi '461 oxidation method to incorporate a feature from the Tokai (JP '154) or Miner (WO '049) oxidation methods, in order to process such object.

Another difference between Applicants' claimed invention and the references cited in the Office Action is that, in the method set forth in amended claim 1, the surface of the object to be processed has formed thereon a plurality of stack-like silicon-layer projections, with a silicon nitride film being formed on the upper surfaces of the projections. Such a surface can be seen, e.g., in Figure 3.

By using active hydroxyl species and active oxygen species under the conditions set forth in claim 1, the difference Δm (see Figure 3) between the thickness of the SiO_2 film on SiN and the thickness of the SiO_2 film on Si is very small. In contrast, JP '154/Tokai merely discloses an oxidizing method applied to a plane surface of an object to be processed. In other words, the present invention provides a method for oxidizing an uneven surface having silicone nitride films on the upper surfaces of the projections to be processed, which achieves an excellent planar uniformity of the film thickness of the oxidized film. Applicants submit that this is not taught in either the primary reference or the secondary references cited in the Office Action.

For at least the reasons given above, Applicants submit that amended claim 1 would not have been obvious over Shoichi '461/ JP '052 in view of WO '049/Miner and further in view of JP '154/ Tokai.

II. Rejection of Claims 7, 8 and 10

Claims 7, 8 and 10 are rejected under §103(a) as being unpatentable over Shoichi '461 in view of Miner.

Claims 8 and 10 have been canceled. Claim 7 depends upon claim 1 and incorporates the features of amended claim 1. Applicants respectfully submit that claim 7 is patentable over Shoichi '461 in view of Miner for at least the same reasons that amended claim 1 is patentable over these references.

III. Conclusion

In view of the amendments and remarks above, Applicants respectfully request that the rejections set forth in the Office Action be withdrawn and that claims 1, 3, 6, 7 and 10 be allowed.

Applicants respectfully request an interview with Examiner Ahmadi to discuss the instant Amendment.

If any additional fees are due in connection with the filing of this paper, such as fees under 37 C.F.R. §§1.16 or 1.17, please charge the fees to Deposit Account 02-4300; Order No. 033082R235.

Respectfully submitted,

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Enclosures: (1) Request for Continued Examination
(2) Petition for Extension of Time (Three Months)
(3) Check for the sum of $1810
(4) U.S. Patent No. 6,566,199 to Tokai et al.